Industrial DG Market Transformation Tools:
DG Operational Reliability and Availability Database

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Operational Reliability and Availability Database Benefits

- Deliverable will be a database of operational reliability data for DG systems.
  - Current DG facility managers better understand reliability and availability performance
    - Their particular units
    - Determine how facilities compare with other DG resources
    - Availability and downtime impacts
  - Potential DG users make more informed purchase decisions
    - System reliability impacts
    - Availability and downtime impacts
    - Onsite ultra-high reliability power system design
  - Policy makers quantify potential benefits of customer-sited DG
    - Standby and back power components of tariffs
    - System reliability impacts

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DG Operational Reliability and Availability Database

- Establish baseline operating and reliability data for industrial distributed generation systems
  - DG system reliability and availability is a critical element in DG market development
- Data from maintenance logs, operation records, and other available sources
  - Exhaustive collection of data from a representative sample of operating facilities
  - Methodology is based on actual customer data
    - Dependent on customer participation
    - Customer-based process creates better understanding of DG operations
    - Leverages substantial prior work by others on evaluating onsite power system reliability
- Identify and classify DG system failures and outages

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DG Operational Reliability and Availability Database

- Links to DOE DER Missions
  - Document Benefits and Disseminate Information
  - Address Infrastructure, Institutional, and Regulatory Needs
- Links to DOE DER Goals
  - Address Institutional and Regulatory Barriers
- Links to DOE DER Strategy
  - Economic Benefits
  - Address Institutional Barriers
  - Reliability of Service
  - Portfolio of Technologies

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DG Operational Reliability and Availability Database

- Technical Approach
  - OR performance
    - data base must address diverse prime mover technologies and applications
    - affected by design, installation, application, and O&M practices
    - data available from industry sources should be used where appropriate
    - statistics must be based on a meaningful sample size
  - Procedures for collecting, processing, and analyzing data must be tightly controlled

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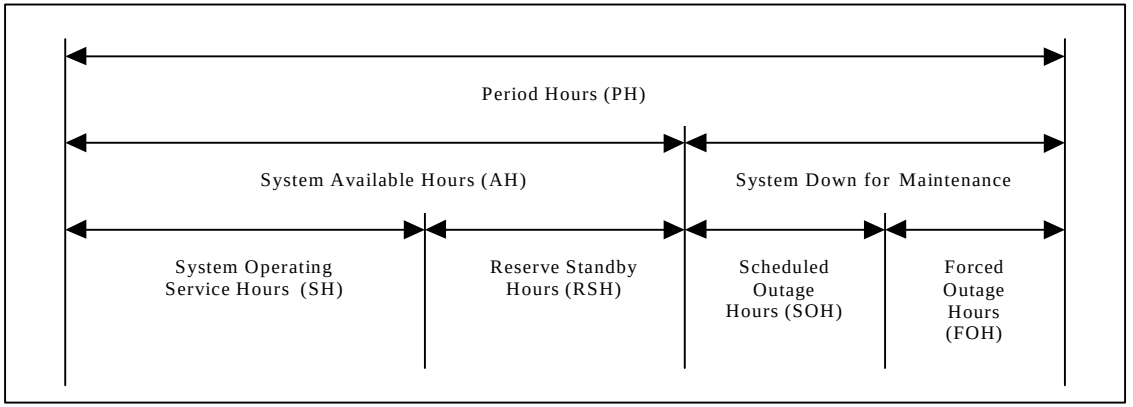
Operational Reliability and Availability Indices



Reliability Performance Indices	Formula
Period of Demand (POD): Measures the time the unit was planned to operate.	POD = PH - RSH- SOH
Availability Factor (AF, %): Measures, on a percent basis, the unit's "could run" capability. Impacted by planned and unplanned maintenance.	$AF = \frac{(PH - SOH - FOH) * 100}{PH}$
Forced Outage Rate (FOR, %): Measures portion of downtime due to unplanned factors.	$FOR = \frac{FOH * 100}{(SH + FOH)}$
Scheduled Outage Factor (SOF, %): Measures percent of time set aside for planned maintenance.	$SOF = \frac{SOH * 100}{PH}$
Service Factor (SF, %): Percent of total period hours the unit is on-line – varies due to site-related or economic factors.	$SF = \frac{SH * 100}{PH}$
Mean Time Between Forced Outages (MTBFO): Measures the nominal time between unscheduled forced outages.	$MTBFO = \frac{SH}{\text{\# Forced Outages}}$.
Mean Down Time (MDT): Measures the nominal duration the unit is down during maintenance events.	$MDT = \frac{SOH + FOH}{\text{\# Forced Outages + \# Plant Outages}}$.

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Project Status

- Project Accomplishments
  - Review of Prior Operational Reliability Work
  - Candidate Screening Process
  - DB Structure
  - Data Collection and Management Plan and Software
- Current Active Task
  - Data Collection and Analysis
- Pending Tasks in Scope of Work
  - Assess Reliability
  - Classification of Failure Causes
  - Reporting

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Project Accomplishments

- Review of Prior Work on Onsite Power Reliability
  - GRI/ARINC Cogeneration Operational Reliability Database
  - FOREMAN Software User Guide – An Operations and Maintenance Data Manager and Reliability Reporting System
  - IEEE Recommended Practice for Design of Reliable Industrial and Commercial Power Systems - IEEE Std. 493-1997 (Gold Book)
  - IEEE Standard Definitions for Use in Reporting Electric Generating Unit Reliability, Availability, and Productivity
  - Reliability Survey of 600-1800 kW Diesel and Gas-Turbine Generating Units, ARINC, IEEE ICPSD 89-02
  - GE - ORAP Database on large gas turbines
- Used to identify industry standards for reliability measures and methodology

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Project Accomplishments

- Candidate screening process
  - Screening criteria
    - Technology category and number of units at each site
    - Completeness of O&M data
    - Prime mover
    - O&M Practice
    - Geography
    - Customer sector
    - WILLINGNESS TO COOPERATE AND PROVIDE DATA
  - Service hours required
    - 2 years of operating service
  - Sources for potential sites:
    - Databases of CHP and non-utility generators
    - Manufacturers
    - Project Developers
    - Gas Utilities
    - Industry Associations
    - Project Sponsors

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Project Accomplishments

- DB Technology Breakdown
  - Reciprocating Engines
    - Group 1: <100 kW
    - Group 2: 100 kW - 800 kW
    - Group 3: 800 kW – 3 MW
  - Fuel Cells
    - Group 4: <200 kW
  - Gas Turbines
    - Group 5: 500 kW – 5 MW
    - Group 6: 5 MW – 20 MW
    - Group 7: 20 MW – 100 MW
  - Microturbines (noted as pre-commercial)
    - Group 8: <100 kW
  - Steam Turbines
    - Group 9: <25 MW

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Project Accomplishments

- Candidate screening process results to date
  - 140 sites confirmed participation
    - Some have multiple units
    - 296 units
      - Multiple fuels
      - Most are gas turbines, reciprocating engines, fuel cells and steam turbines
      - Microturbines have low operating hours and confidentiality issues
        - Will be noted as pre-commercial products at this time
    - Still pursuing additional Industrial Center leads
      - Favor sites in common location to facilitate logistics of data collection
  - >1600 facilities contacted for potential participation
  - Time-intensive

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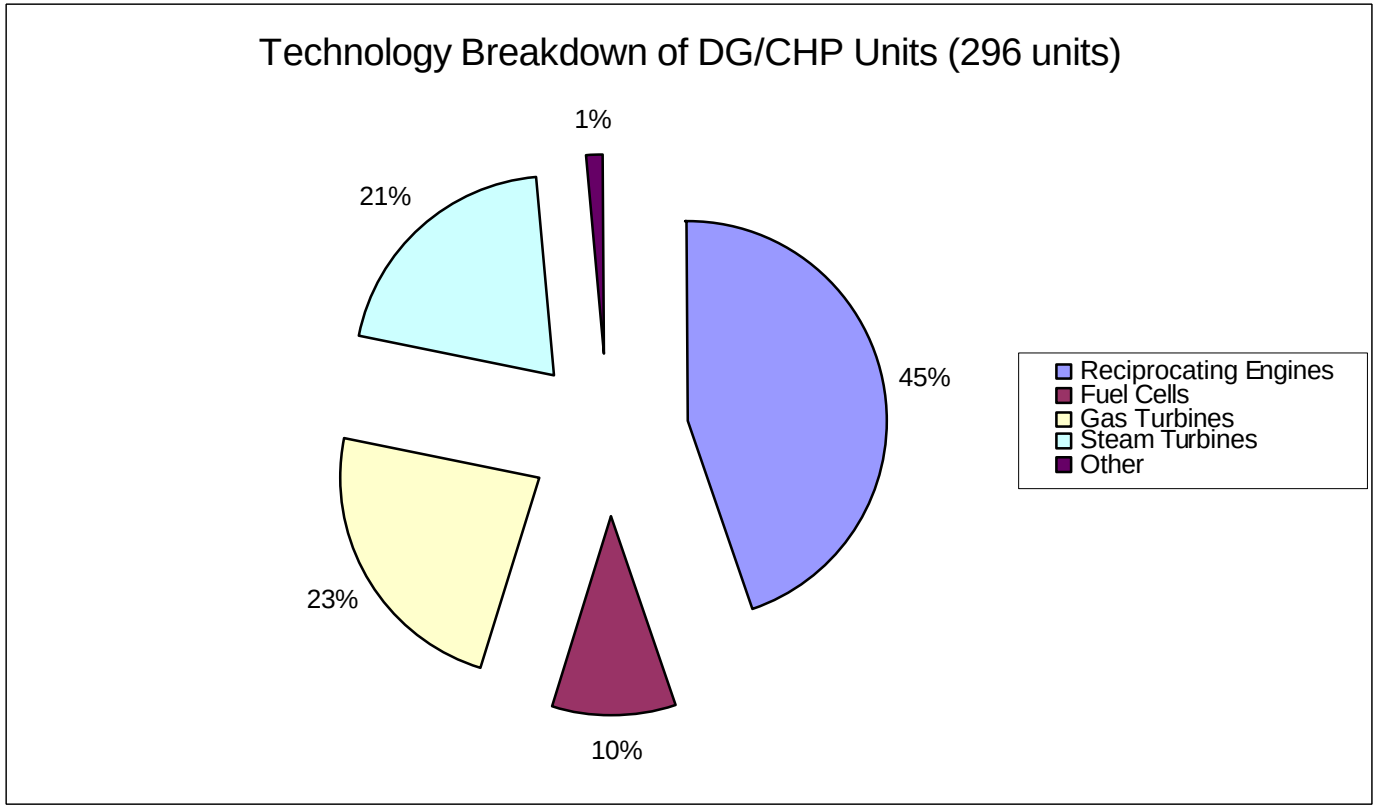
Project Accomplishments

- Candidate screening process results to date



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Project Accomplishments

- Database Content
  - Plant Configuration
    - Design and equipment features
  - Subsystem Operations
    - Prime mover subsystem operations data for each plant
  - Event Description
    - History of planned and unplanned maintenance
  - Reports
    - Plant Configuration, Subsystem Operations, and Event Description
    - Summary OR statistics for a unit, subsystem and technology
  - Facility sites, manufacturers and models are anonymous

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Project Accomplishments

- Data Collection and Management Software
  - Data Input Format
    - Simple and consistent with maintenance logs
    - Essential O&M data:
      - Monthly operation reports that describe unit electrical generation and engine service hours
      - Maintenance log books
      - Service reports that describe planned and unplanned outage maintenance
      - Outage summary reports
      - Service reports
  - 6 Modules
    - Facility/plant information
    - Power unit information
    - Power generation history
    - Monthly plant generation history
    - Event log data
    - Equipment failure cause list

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Planned Key Milestones

- Site Identification
- DB Format & Structure
- Data collection and management software
- Detailed data collection (November 2001-March 2002)
- Supplemental sites (November 2001-February 2002)
- Reliability Assessment (February 2002-May 2002)

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